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THE SPIRIT OF ALCHEMY IN MODERN INDUSTRY

NEVER in the history of the world has there been such a time of intense human activity as the present: never a time of such gigantic undertakings, such marvelous achievements. Notwithstanding, the curve of progress is still an ascending one; although for some nations it has run paralel to its axis for many centuries, yet nowhere on the earth is there not at present a marked break in the line which for so long has represented a monotonous level in human affairs.

While there has been remarkable progress in ethics, culture and the fine arts, this world movement in human endeavor is epitomized in the expression "modern industry." Of the many factors which have entered into the advance in industry as a whole, possibly the most important is found in the manufacture and use of power. Where once we measured results by what a man could do, or later what a horse could do, now we measure the power at our command by thousands of kilowatts. We have had an age of steam, and we are passing through an age of electricity, and what next? Many think it will be an age of unprecedented chemical development. We have reason to be well satisfied with our present achievements; we do things so much more quickly and on so much larger a scale than our ancestors did. But at this enviable rate we can see the end of our resources—coal, timber, iron ore, are already measured in years. We must improve our present methods. We must inaugurate along every line of great endeavor a systematic search for new

truths, new light into the secrets of nature in order that we may live and work more efficiently.

It may seem a long step from a consideration of human dynamics at the intensity of the present, to the work of the alchemists of centuries ago, with all their magic and mysticism, their solitary lives and cherished secrets. But in reality there is something in common between these ancient investigators and the leaders in modern industry; and in looking ahead as to how we can best utilize the possibilities of the future we may learn something by considering the mistakes of the past.

The captains of industry and their army of co-workers are still alchemists at heart; they still strive to transmute the base materials of the earth into gold. But where the alchemist was satisfied only with seeing the noble metal glittering in his alembic, the modern business man is content in obtaining from his still a treasury certificate. It requires no magic philosopher's stone to effect a transmutation of paper into gold when once the former bears the proper inscription. Wherein have modern methods of alchemy changed from those of that eminent scholar who bore the name Phillipus Aureolus Theophrastus Bombastus von Hohenheim, and who lived and worked in the twelfth century and an account of whose checkered career has been handed down to us?

The spirit of alchemy is well represented in the word itself. It is an Arabic prefix, and the old Latin word for Egypt, meaning the dark, secret or hidden. It was the black art of the ancients. Another name sometimes used was "hermetic art," meaning also closed or sealed from view. The goal of those men from the gray of antiquity to the monks of the middle ages was the discovery of a way to make gold and silver from the metals already known, such as mercury and copper, tin and iron. We can see as we look back over their labors how now and again they received just the encouragement necessary to keep alive the embers of hope which glowed in each one's primitive laboratory. By melting the base metal copper with an earth which we now know carried arsenic, a silver white metal was formed; how easy to believe that this was an impure silver which needed but refining to be the longed-for result. When iron was left in a water solution of blue stone it disappeared and copper was found in its place. Surely this was a transmutation of iron and copper. Why not under proper conditions a further change of copper into gold?

But very many patient and able men devoted their lives to this fruitless search without material progress being made. The alchemists of Arabia and early Germany were little wiser than their predecessors of Egypt many centuries before them. The explanation of this lack of progress is to be seen in the profound secrecy which was at all times maintained. When some enterprising worthy did take it upon himself to transcribe for future generations his knowledge of the mystic art, his sentences were so ambiguous, and his diction so involved, as to make the whole entirely meaningless. Mysterious symbols were employed to render imitation the more difficult.

There was, therefore, no accumulation of knowledge or experience, and each succeeding investigator continued to grope in the darkness which had ever enveloped his calling, without deriving any benefit from the labor of either his predecessors or his contemporaries. The great and insurmountable obstacle to progress was nothing more than the jealous secrecy engendered by selfish competition. Both confidence and cooperation were entirely wanting.

Each one feared that his neighbor might profit by his experience were it to become known, never realizing that he must in the end get much more in return than he gave. There was but one of him, while there were many of his neighbors.

But in the thirteenth century there came a change. One Roger Bacon, who from his rare accomplishments and erudition was called Doctor Mirabilis, and who firmly believed in the existence of the philosopher's stone, was being tried at Oxford for sorcery. To disprove the charges against himself, he wrote a celebrated treatise with a long Latin name, in which he showed that phenomena which had been attributed to supernatural agencies were in fact due to common and natural causes. He pointed out further in his brief, a possible distinction between what he called theoretical alchemy, or work which could advance the knowledge of natural phenomena, and practical alchemy, or the striving after immediately usable information. He is to be regarded as the intellectual originator of experimental research, and by his generous treatment of the knowledge gained, gave to the movement the impetus for which it had so long waited. The limitations of this paper preclude my following in any detail the development of chemistry through the succeeding centuries, but it can be easily shown that just as knowledge was sought after for its own sake, and in proportion as there was free and honest intercourse between the investigators of the time, just so rapidly was real progress made.

The course of human events has been compared to a pendulum. We tend to swing to extremes; to go too far first in one direction, and then in the other, when real progress lies in the middle. The period of alchemy represents the pursuit of science for selfish and sordid ends; its sole object was that of making gold. The pendulum was at one extreme of its path. But at that time, as at this, the making of gold by whatever means did not in itself bring happiness or contentment, or even success. With the appearance of men who took an absorbing interest in the study of natural phenomena, for the purpose of gaining a deeper insight into the world around them, when investigations were undertaken from a desire to know, and to acquire knowledge which could become the property of the world at large, the pendulum began to move back.

For years the efforts of investigating minds were devoted to the explanation of the phenomena of nature; to the discovery of new laws and principles; to the accumulation and organization of facts, into what is called a science—to a real search for truth. This resulted in a general uplift of humanity, an advance in civilization, which can not be described or measured in words. It was a time when the human mind was struggling to determine realities in the midst of tradition and superstition; to realize that nature is always complex but never mysterious; that dependence should be placed in proven facts rather than the vagaries of priests and philosophers. Man became intellectually free.

But for many years after the broad generalizations upon which modern chemistry is founded were well established, industry did not profit much by scientific work. One hundred years ago the men who smelted the iron and copper, the lead and zinc, knew little of the principles underlying their practise. Leather was tanned, woolens and silks were dyed, porcelains and glass were made, without the aid of those who alone knew the chemistry involved. These were times when the advance in chemical knowledge was far ahead of the industries on the success of which

our material comforts depend, and which then stood in such need of help.

A rational attempt to apply chemical knowledge and methods to the industries commenced about 1850, and is in reality contemporaneous with the founding of the Institute of Technology which we to-day celebrate. It was in 1856 that Perkins made the first synthesis of a coal-tar color, and founded the industry which has become the most remarkable example of applied chemistry that we have. In 1855 Bessemer introduced his revolutionary process for making steel, made possible by the clear understanding of the nature of steel through improved analytical processes. With the founding of the Institute of Technology and other similar institutions, which not only did its part in advancing science, but taught its students how to apply this science to the problems of the day, our industrial progress has gone forward with leaps and bounds.

I would point out in passing that a great contribution in the aid of civilization is not necessarily made by the simple discovery of a scientific fact. Although, for example, the reactions underlying the ammonia-soda process were well known for many years, this knowledge did not benefit the world until the genius of Solvay made through it pure and cheap soda available. Cavendish long ago discovered that an electric arc produced nitric acid from the air; the world waited until a few years ago in order to profit by this knowledge, when the researches of Birkeland and Eyde made of the idea an industrial process. It was for this ability to apply scientific facts to the necessities of the times, that the world was looking at the time of the founding of the Institute of Technology. Much pure science we had, but it was as yet largely "uncontaminated by the worship of usefulness," if I may quote a contemporary. It was to just the kind of men which the Institute of Technology turned out—men who could appreciate the beauties of pure science, and at the same time had the ability to apply it, that our marvelous advance in material prosperity was due.

But to-day there can be seen evidences of a swing of the pendulum past the center, and again to approach an undesirable extreme. Research has become a word to conjure with. Private bequests for institutions of research in almost every field of science are made in units of millions of dollars. The most significant movement, however, is the very general establishment of laboratories for research, and especially chemical research, by great industrial organizations. This movement is but in its infancy, and it is here that a return of the old spirit of alchemy is to be feared. It has its foundation in the impatience of the more enterprising firms to wait for scientific facts and principles to be discovered by others; hence their willingness to appropriate often very large sums of money and to actively enter the field of what is called research in applied chemistry.

From what has already been said, there may appear to be a paradox in the expression "research in applied chemistry." How can the element of research enter into the work of applying to definite ends the facts already established as true by others? Is there a difference between research in so-called pure chemistry, and research in what, for want of a better name, we will call applied chemistry. Possibly I can make the distinction clear by a rough analogy. The development of research in a science may be compared to the exploration of a new country. New roads are to be laid out, tunnels bored and bridges built; in other words, new problems solved. This may be done in two ways. First, constructive work may be

undertaken wherever an interesting problem presents itself, without regard to whether there is a demand for such structure or not. It is built because of the interest of the builder in solving this particular difficulty, and the pleasure he takes in it, knowing also that some time it will be utilized. As a rule he is under no great pressure to get the structure completed. This may represent the method of pure chemistry, and the great advance in scientific knowledge of the past was made by boring just such tunnels and building just such bridges. The industries have used these structures when they could, or when some second builder could adapt them to use. Research in applied chemistry differs from that just described only in this—I should say, it *needs* differ only in this—that when a problem is to be solved, a bridge to be built, the work is undertaken at a point where there is a demand for its use; where people are waiting to cross over so soon as it is finished. The method of building is no different, the difficulties no less. The fact that the bridge is to be used makes the work of building no less dignified, nor is it possessed of less pleasure. In both cases the builder profits by all that has been done before, and contributes his bridge and the new materials of construction he may have found, to those who may come after him. To cite an example from experience, suppose I determine the electrical conductivity of metallic oxides at high temperature with great accuracy, and publish the results without reference to any particular application of the data. This is pure science. But suppose I am trying to perfect an electrical heating unit for high temperatures, and in insulating my resister I do this identical piece of work, namely, measure with great accuracy the electrical conductivity of metallic oxides at high temperature, and again publish the results. This is applied science. The work need not differ in the least degree. It can be as accurately done and the conclusions as scientifically drawn. The mere fact that the data will be used for some practical end need not make the work any less purely scientific.

Why then has research in pure chemistry commanded more respect than research in applied chemistry? Why did an eminent writer a few months ago lament the fact that there is not more research "uncontaminated with the worship of usefulness"? Why does usefulness contaminate? I think it lies in this: the investigator of pure science works in the broad daylight, throws his product open for inspection, and invites all to come and use it when they can. In applied chemical research the spirit of alchemy tends to creep in. The builder keeps his materials of construction, and his designs, a secret, and so boards up his bridge that those who cross over it can not see how it was built, nor profit by his experience. The moment a thing becomes useful we become jealous of its possession; we become narrow in our horizon; we sell our scientific birthright for a mess of potage; we become alchemists.

There is a heavy moral obligation on the part of large industrial organizations having fully equipped research laboratories, to contribute their share to the advance of the world's knowledge. They have well-stocked libraries, and are provided with all the current periodicals; they profit by all the scientific work which has been done and is being done. This is as it should be, and such firms are to be commended for their progressiveness. But is this not a reason why such laboratories should do their part in adding to the sum of available knowledge? There is in every laboratory much work which could be published and yet conserve the interests of the corpora-

tion. First there are the results which may not have proved valuable to the laboratory in which they were obtained, but which would be of immense value to some one else working in an entirely different field. Second, there are those results of value to the laboratory possessing them, but which could be published in an unapplied or "pure" form and which would make an important contribution to science and at the same time the publication would work no injury to the company or corporation most interested. And finally there are those results of operations and processes, machines and apparatus, which, if the truth were known, are possessed by a large number of concerns, but are held as valuable secrets by each. Every one would profit and no one be the loser by so far-sighted and generous a policy. Germany is very justly held up before us as a shining example of marvelous industrial progress and prosperity. A very great deal of the credit for her present position is due to her splendid educational system. But no small factor in her national progress is the helpful attitude which her industrial organizations take toward the publication of scientific data. The individual does not suffer, while Germany both from a purely scientific and an industrial standpoint is rapidly advanced. But too often with us the president and his board of directors are alchemists; they fail to see why, if they pay the salaries of their research men, they should give to the public, or their competitors, any part of their results. They exclaim "what has posterity done for us?" They would have their laboratories remain the secret chambers of the alchemists, and continue to improve their methods of changing baser materials into gold without regard to the obligations which they owe to their fellows.

It requires no extensive mathematical calculation to prove that the manufacturers themselves would be the ones to profit by such a liberal treatment of the results of scientific work. Of one hundred manufacturing concerns each one would give but one per cent. of the whole contribution, while he would receive the remaining ninety-nine per cent. He could not in the long run be the loser. But of vastly more importance, he would feel and know that his organization was taking part in a world movement toward that increase of human knowledge upon which all real progress depends. Why become selfish and sordid so soon as one's scientific work becomes of immediate value to one's fellows? The greater sense of satisfaction, the greater success even of an industrial organization, lies in a fuller, freer, more generous publicity of the scientific results of their laboratories. Would that each such industry might benefit by the experience of Solomon, King of Israel, who, when asked, "What shall I give unto thee?" replied, "Give me knowledge and wisdom," and he was answered, "Wisdom and knowledge are granted unto thee; and I will give thee riches and wealth and honor."

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APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE[1]

The growth of the National Department of Agriculture during the past ten years has far exceeded that of all of its preceding history. This was pointed out by Hon. Charles F. Scott, chairman of the House Committee on Agriculture, in submitting the new agricultural appropriation bill last winter. Its growth as marked by a decade has been phenomenal, viewed either from the standpoint of its scope and authority, its material resources, or its personnel.

[1] From the *Experiment Station Record*, April, 1911.

As a full-fledged department with a cabinet minister at its head, the department dates only from 1889. But if we go back to 1839, when $1,000 was appropriated for "agricultural statistics," and include every dollar appropriated out of the treasury of the United States for agricultural purposes down to and including the year 1900, the total sum is, as Mr. Scott pointed out, only $45,102,616, while the aggregate of all the money appropriated from the end of 1900 to the end of the current fiscal year reaches a sum nearly double this, or $90,012,058. For the fiscal year 1901 the appropriation for maintenance was $3,304,265.97. This year the department has at its disposal $15,470,634.16. "Ten years ago the total number of persons employed in the department was 3,388; this year if all the rolls were called an army of 12,480 men and women would respond."

Under the bill which the committee submitted, and which after considerable discussion and amendment received the signature of President Taft March 4, provision is made for an even greater development during the ensuing year. The aggregate amount carried by the act is $16,900,016, which by far exceeds that granted in any previous measure, and is $887,950 in excess of the estimate submitted by the department.

There is an apparent increase over the appropriation act for 1911 of $3,412,380, but of this $720,000 is only nominal, since it merely replaces what has hitherto been provided automatically as a permanent appropriation to the state experiment stations under the Adams Act. It will be recalled that by the terms of that act as subsequently construed in the appropriation act for 1907, definite appropriations were made only until July 1, 1911. The action taken by congress now provides for the continuance of the Adams Fund on the same basis as the Hatch Fund, requiring the amounts to be appropriated annually in the agricultural bill. With due allowance for this item, however, there is still an actual enlargement of the appropriations of every bureau, and a net increase of fully 20 per cent. for the department as a whole.

In general the increased appropriations are for the purpose of extending and developing lines of work already under way rather than the undertaking of new projects, and some of the principal increases are for what may be termed the administrative activities of the department. One of the largest new items is an appropriation of $1,000,000 for fighting and preventing forest fires in the national forests in cases of extraordinary emergency. This appropriation is in addition to the regular appropriation of $150,000 for fire fighting under ordinary conditions, and supplements deficiency appropriations of over $900,000 incurred as a result of the disastrous fires of last summer.

The federal meat inspection, which has been enforced by the department from a permanent annual appropriation of $3,000,000, receives an indirect increase of $155,000 through the transfer of its clerical force to the statutory roll of the Bureau of Animal Industry. The Bureau of Chemistry receives $60,000 additional for the enforcement of the Food and Drugs Act, and the Weather Bureau $75,490 additional for its weather service. Provision is also made by an appropriation of $87,000 for the enforcement of the Insecticide Act, which became effective January 1, 1911, and for which a deficiency appropriation of $35,000 had been allowed for expenses to July 1.

A number of propositions involving general legislation were considered in connection with the bill, but as finally enacted the law remains substantially a routine measure. The secretary was again authorized to continue investigations on the cost of food supplies at the farm and to the consumer; and a special appropriation of $5,000 was added for a study of chestnut bark disease.

Comparison of the allotments to the various bureaus in this act and those preceding it is rendered difficult because their clerical employees will, in accordance with a clause inserted in the act of 1911, be transferred on July 1 from the various lump-fund appropriations on which a portion of them had been carried to the roll of positions specifically provided for. These transfers in certain cases—

as, for example, in this office and the Bureau of Statistics—involve but a few employees, but in the case of the Forest Service, where 1,894 forest rangers and similar employees are to be transferred, they occasion an apparent increase in the appropriations for statutory salaries from $60,200 for the current year to $2,318,680, with a corresponding deduction from lump-fund appropriations. The lump-fund appropriations, therefore, for a particular purpose, such as biological investigations or soil-survey work, no longer indicate so completely as they did previously the entire expenditures for these objects. Comparison is still possible, however, as regards the aggregate appropriations of the bureaus.

The Weather Bureau receives a total of $1,600,250. Of this amount, $15,000 is for the restoration of the Weather Bureau station at Key West, Florida, wrecked by hurricanes in October, 1910. The allotment for maintenance of the bureau printing-office was reduced to $18,000 by reason of the recent transfer of a portion of the equipment to the Government Printing Office. For investigation of climatology and evaporation $120,000 was provided, as at present.

The appropriations to the Bureau of Animal Industry aggregate $1,654,750. Aside from the increase due to the transfers from the meat-inspection act, previously referred to, the chief additions are those of $7,120 for the tick-eradication work, making that appropriation $250,000; an increase of $7,000 for the work of the Dairy Division, making its total $150,000; and of $7,640 for the Animal Husbandry Division, or $47,480 for that work. Under a new clause inserted in the act, the Secretary of Agriculture is authorized to permit, under certain conditions, the admission of tick-infested cattle from Mexico into those portions of Texas below the quarantine line.

New appropriations were made of $65,000 for the purchase of land for quarantine stations near Baltimore, Md., and Boston, Mass.; $10,000 for equipping the 475-acre experiment farm which has recently been acquired at Beltsville, Md., and $16,500 for constructing buildings at this farm and that at Bethesda, Md. It is expected to utilize the Beltsville farm for the experimental work of the Animal Husbandry and Dairy Divisions, and to reserve that at Bethesda for pathological investigations.

One of the largest increases in the bill was accorded to the Bureau of Plant Industry, which will receive $303,480 additional, making its total $2,061,686. The lump-fund appropriation for general expenses is $1,441,536, which is divided among thirty projects. Some of the largest of these are $350,000 for the boll-weevil campaign (a net increase of $106,945); methods of crop production in the semi-arid or dry-land sections, and for the utilization of lands reclaimed under the Reclamation Act, for which a net increase of $38,270 and a total of $143,060 is granted; $142,920 for the farm management studies, of which $4,000 is to be used in agricultural reconnoissance work in Alaska; studies of the production, handling, grading, and transportation of grains, for which $135,005 is available, an increase of $24,500; and the studies of fruit improvement and the methods of growing, packing and marketing fruits, which will have $87,735. The investigations of the cotton industry were extended to include the ginning and wrapping of cotton.

For the purchase and distribution of valuable seeds and plants the allotment made was $289,680. This is an apparent decrease of $19,910, but it is accounted for in part by transfers of clerical employees to the statutory roll of the bureau, and in part by the segregation as a distinct project of $20,000, which was formerly supported from this fund. The two items comprising this appropriation are the congressional seed distribution, which is continued on the usual basis, with $237,160, and the allotment for the introduction of seeds and plants from foreign countries, which is increased to $52,520.

The appropriations to the Forest Service reached a total of $5,533,100, in addition to the various emergency appropriations to which reference has been made. This, as usual, represents the largest appropriation to any one bureau, and is also the largest increase

over the previous year, the total for 1911 having been $5,008,100. The policy of definite allotments to each of the 161 national forests for maintenance was continued. The Nebraska National Forest was authorized to furnish young trees free of charge to settlers in the surrounding region.

The sum of $150,000 was granted for fighting forest fires and for other unforeseen emergencies, of which $70,000 is immediately available. The allotment for permanent improvements on the national forests was increased from $275,000 to $500,000. Provision was made for the refunding to claimants of moneys erroneously collected in the administration of the national forests, and for the granting of easements under certain conditions for rights of way across the public lands, national forests, and reservations, for the transmission of electrical power and for telephone and telegraph purposes.

Liberal provision for the development of investigational work was also made, $177,040 being granted for investigations of methods for wood distillation and preservation and the economic use of forest products, including the testing of woods for paper-making, together with $18,420 for investigations of range conditions within National Forests and range improvement, $251,168 for silvicultural and dendrological experiments, and $33,760 for miscellaneous forest investigations and the preparation and dissemination of results.

The appropriation of the Bureau of Soils was increased to $262,060. No appropriation was made for soil erosion investigations, for which $5,000 has been allotted annually for many years. The soil survey work received $145,000, a net increase of $13,040, with a provision added limiting to 10 per cent. the expenditures in any state.

The bureau was authorized to undertake a new line of work by the appropriation of $12,500 "for exploration and investigation within the United States to determine a possible source of supply of potash, nitrates and other natural fertilizers," $2,500 being made immediately available. It is expected that particular attention will be devoted to possible sources of potash in view of the present situation as regards the German potash supply. The work will also be supplemented by researches to be conducted by the Geological Survey, which received authority in the sundry civil appropriation act to expend $40,000 "for chemical and physical researches relating to the geology of the United States, including researches with a view of determining geological conditions favorable to the presence of potash salts." According to a recent announcement from the survey, the expenditure of half this appropriation for the potash exploration is contemplated.

The Bureau of Entomology receives an aggregate of $601,920. This is an increase of $69,740, mainly for the extension of work to the alfalfa weevil and for enlarging the investigations on insects affecting rice and sugar-cane, for demonstration work against forest insects, and for additional studies in bee culture. The largest single allotment is for the continuation of the campaign against the gipsy and brown-tail moths, for which the appropriation is $284,840.

The large proportionate increase of $52,780 was accorded the Bureau of Biological Survey, making its total $139,700. All the various lines of work were continued on a more comprehensive basis, and new items were included of $2,500 for the purchase, capture, and transportation of game for national reservations, and of $20,000 for the feeding, protecting and removal of elk at Jackson's Hole, Wyo., and vicinity. The latter appropriation is made immediately available and remains available until expended.

The activities of the Office of Public Roads have been rapidly increasing in recent years, and to keep pace with the growing demands the appropriation was increased from $114,240 to $160,720. A new line of work authorized is the conducting of field experiments in road construction and maintenance, for which $10,000 is granted.

The total appropriation of the Office of Experiment Stations is $1,864,000, of which $1,440,000 is allotted to the state experiment stations under the Hatch and Adams Acts.

Of the remainder, $56,500 is for statutory salaries and $37,500, a net increase of $5,000, is for general expenses. The allotment of $10,000 for the agricultural education service was continued as at present.

The nutrition investigations received an increase of $5,000, making $15,000 available for this purpose. This increase will enable further extension of these investigations and the preparation of popular bulletins setting forth plans for the more economical and effective utilization of agricultural products as human food, for which data a strong demand has been in evidence.

An estimate of $20,000, submitted for the preparation, publication and dissemination of original technical reports of the scientific investigations of the experiment stations by the Secretary of Agriculture in cooperation with the Association of American Agricultural Colleges and Experiment Stations, was favorably recommended by both the house and senate committees, but failed of passage.

The Alaska, Hawaii and Porto Rico experiment stations were given $30,000 each, an increase of $2,000 in each case to equalize their funds with those received by the state stations from federal funds, and the Guam Station was continued at $15,000. The clause requiring the expenditure of $5,000 by the Porto Rico Station for coffee experiments was omitted, thereby restoring the coffee work to the same basis on which it has been conducted for many years previous to the passage of the act for 1911.

The irrigation and drainage investigations each received $100,000, a net increase of $32,820 and $25,980, respectively. These increases will enable the extension of these lines of work, especially in the rendering of assistance to settlers in newly irrigated regions, and in formulating plans for the reclamation of swamp lands. The provision requiring a special report of the aggregate expenses in the drainage investigations to date and the areas in the several states and territories which have been investigated was continued.

The work of the remaining bureaus was provided for along substantially the present lines. Including the increase previously noted for the enforcement of the Food and Drugs Act, the Bureau of Chemistry will receive $68,080 more than at present, and a total of $963,780. The Bureau of Statistics is given $231,620; the Library, $40,500; the Office of the Secretary, $276,450; the Division of Accounts, $97,520; the Division of Publications, $209,960, and the fund for contingent expenses, $110,000. These all contain small increases, occasioned in general by the growth of the department.

In addition to the sums carried in the appropriation act itself, there should also be considered the appropriation of $470,000 for the department printing and binding, which appears in the appropriation act for sundry civil expenses. This represents a nominal increase of $10,000, but $22,000 more than at present is assigned to the Weather Bureau by reason of the transfer of a portion of its branch printing office, making a virtual decrease of $12,000 for the remainder of the department. There is also to be added the permanent appropriation of $3,000,000 for the meat-inspection work. Deficiency appropriations were granted, as well, of $923,192.90 for the fighting of forest fires in 1910, the relief of employees of the department killed or injured in that campaign, and for horses and equipment destroyed during it, and $35,000 for the enforcement of the Insecticide Act during 1911.

Additional funds which will be administered by the department are provided in the measure enacted at the recent session of congress for the protection of the watersheds of navigable streams, and popularly known as the "Appalachian Forest Reserve" Act. Under this act the secretary of agriculture may expend $200,000, in cooperation with states requesting it, in the protection from fire of the forested watersheds of navigable streams, irrespective of ownership. He is further authorized to purchase, following a favorable report by the Geological Survey and the approval of a National Forest Reservation Commission, of which he is *ex-officio* a member, lands located at the headwaters of navigable streams,

and to administer these lands as permanent national forests. An appropriation of $2,000,000 is made annually until July 1, 1915, for the examination and acquisition of these lands, together with $25,000 additional annually for the expenses of the commission.

Eliminating the deficiency appropriations and that for the Forest Reservation Commission, these various appropriations, which are intimately connected with the work of the department, would, if added to the regular appropriations, make a grand total of $22,570,016. This is a large sum, but as was pointed out by Chairman Scott in concluding the presentation of the bill, "the money appropriated for the Department of Agriculture is an investment and not an expense. And that it has been a good investment the statistics showing the expansion of agriculture and the improvement in methods throughout our country bear eloquent witness. During these past ten years, while the Department of Agriculture has been expending $90,000,000, the farmers of the United States have added to the wealth of the world the stupendous and incomprehensible sum of $80,000,000,000. Without anything like a corresponding increase in the area of land under cultivation, the value of the farm products of our country has risen from slightly more than $4,000,000,000 ten years ago to nearly $9,000,000,000 in 1910.

"The conclusion is inevitable, therefore—and that conclusion could be made incontestable by innumerable other proofs if time permitted—that the farmers of America are applying better methods and getting better results from their labors than ever before. And in devising these better methods, in pointing the way for better results, the Department of Agriculture has been the undisputed leader, as it should be, and has thus beyond cavil or question derived from the money it has expended a percentage of profit to all the people which can not be calculated."

APPROPRIATIONS FROM THE BACHE FUND OF THE NATIONAL ACADEMY OF SCIENCES

DURING the past year the following grants have been made from the Bache Fund of the National Academy of Sciences:

May 20, 1910. Franz Boas $300
Investigation of head-forms of new-born children.

May 20, 1910. John A. Parkhurst 500
Photometric and spectroscopic survey of circumpolar stars.

June, 1910. Louis T. More 500
Continuation of investigation on discharge of electricity through gases; radioactivity and electro-magnetic action (second appropriation; first made in May, 1908).

December 9, 1910. S. F. Acree 400
Investigation of reactions of alkyl halides with sodium ethylate.

January 25, 1911. P. W. Bridgman 500
Effects of high pressure; variation of freezing point of liquids with pressure; compressibility of liquids and solids; and mechanical properties of metals.

February 2, 1911. Francis B. Sumner 250
Experiments on effects of external conditions on growing white mice.

April 17, 1911. E. W. Washburn 200
To prepare and measure the specific conductance of pure water.

April 17, 1911. Gilbert N. Lewis 500
The determination of the electrode potentials of the alkali metals and of the metals of the alkaline earths.

April 17, 1911. Charles C. Adams 125
For the expense of completing and preparing for publication a paper entitled "The Geographic Variations and Relations of CO."

SCIENTIFIC NOTES AND NEWS

COLUMBIA UNIVERSITY has conferred its doctorate of laws on Professor C. F. Chandler, who retires this year from the chair of chemistry after forty-seven years of active service.

SIR WILLIAM T. THISTLETON-DYER, formerly director of the Kew Botanic Gardens, will receive the honorary doctorate of science from Oxford University on June 28.

DR. C. S. SARGENT, director of the Arnold Arboretum, Harvard University, has been elected an honorary member of the Société Nationale d'Acclimation de France, and an honorary member of the Royal Irish Academy.

Dr. Joseph H. White, of the U. S. Public Health and Marine Hospital Service, was elected president of the American Society of Tropical Medicine at its recent New Orleans meeting.

The trustees of the Jefferson Medical College, Philadelphia, on the recommendation of the faculty, have elected Dr. Warren B. Davis as the Corinna Borden Keen research fellow of the college. This election carries with it an award of $1,000 for the purpose of a year's research work in Europe upon any subject approved by the faculty.

A grant of two hundred dollars has been made from the C. M. Warren Fund of the American Academy of Arts and Sciences to Dr. S. F. Acree, Johns Hopkins University, for the study of the physical and chemical properties of pure ethyl alcohol. A grant, amounting in all to one hundred and fifty dollars, has also been made to Dr. J. E. Gilpin, Johns Hopkins University, in aid of his work on the study of the nature and source of petroleum, which involves results on the fractionation of petroleum by means of selective absorption by porous materials, such as fuller's earth.

Curator Bashford Dean, of the department of ichthyology and herpetology in the American Museum of Natural History, has been appointed the official representative of the museum at the twenty-second annual conference of the Museums Association, which will be held in Brighton, England, from July 10 to July 15, under the presidency of Mr. H. M. Platnauer, B.Sc., and at the one hundredth anniversary of the founding of the Universitas Regia Fredericiana at Christiania, which is to take place on September 5 and 6.

Professor Albert Johannsen, of the department of geology of the University of Chicago, will sail from Montreal on the seventeenth of this month to inspect the petrological laboratories of the principal European Universities.

Dr. C. H. Shattuck, head of the department of forestry at the University of Idaho, will during the coming summer conduct a forestal and floral survey of the Kaniksu National Forest. This survey will be similar to that conducted by him last summer on the Clearwater National Forest. The party will consist of twelve men with headquarters at Coolin, Idaho.

Sir John Murray lectured before the California chapter of Sigma Xi on May 11 on "The Floor of the Ocean," using illustrations from the recent cruise of the Norwegian steamer *Michael Sars* in the Atlantic.

The annual public address before the University of Michigan chapter of the society of the Sigma Xi, was delivered, June 2, by Professor J. Playfair McMurrich, of the University of Toronto, the subject of the address being "Sir Francis Galton, his Life and Work." Professor F. G. Novy was elected president of the chapter.

An address on "The Evolution of Human Teeth and their Racial Differences," was delivered by Dr. A. Hrdlicka, of the Smithsonian Institution, on June 1, at Toronto, under the auspices of the Ontario Dental Society, and on June 27 before the Alumni of the dental department of the University of Buffalo. On May 25 a similar address was given by Dr. Hrdlicka before the Maryland State Dental Association, at Baltimore.

Mr. A. D. Darbishire has been appointed to the newly instituted lectureship in genetics, at the University of Edinburgh, and will deliver a course of six lectures on heredity during the summer session.

The statue to Captain Cook, the plans for which have been noted in Science, will be placed on the Mall side of the Admiralty arch, on the right hand going towards Charing Cross. The execution of the statue has been entrusted to Sir Thomas Brock.

The executive committee on the Chiene portrait fund has resolved to hand to the University of Edinburgh the balance of the fund, about $1,500, for the foundation of a bronze medal, to be called the "Chiene Medal in Surgery."

Dr. Edward Burnett Vorhees, professor of agriculture at Rutgers College and direc-

tor of the N. J. Agricultural Experiment Station, known for his important contributions to agricultural chemistry and agricultural education, died on June 6, aged fifty-four years.

PROFESSOR WILLIAM RUSSELL DUDLEY, since 1893 professor of botany in Stanford University, died on June 4, aged sixty-two years.

MRS. EMMA WILSON DAVIDSON MOOERS, custodian of the neuropathic collection of the Harvard Medical School, previously assistant pathologist in the Worcester and Maclean Hospitals, died on May 31.

THE death is announced of Mr. Robert Service, of Dumfries, Scotland, who while conducting the work of a nursery made valuable contributions to ornithology.

THERE is existing a vacancy in the position of physical chemist in the Bureau of Mines, Department of the Interior, at Washington, D. C. This position requires a high order of scientific training equivalent to that required by the leading American universities for a professorship in physical chemistry. A man is wanted who will be able to organize, to participate in, and to supervise the physical and chemical investigations of problems that serve as a basis for modern metallurgical methods, especially the problems connected with the ores, operations and products of modern smelters. The government is endeavoring to find the best man available for this work and has no particular individual in view. The methods of procedure will be similar to those of an educational institution or business organization, whose board of trustees or governing officers desire to fill professional or technical positions. The qualifications and fitness will be determined by an impartial board of scientific men. The entrance salary for this position is $4,000 per annum. There is also existing a vacancy in the Bureau of Mines in the position of chief mechanical engineer at an entrance salary of $4,800 per annum. For this position it is desired to secure a man who will be able to participate in and supervise the various mechanical engineering problems appropriate to the work of the Bureau of Mines, including investigations looking to a greater efficiency in the utilization of mineral fuels at the various heating and power plants of the government in different parts of the country, and the mechanical problems connected with various mining operations. Qualified persons who are interested in these positions are invited to communicate with the U. S. Civil Service Commission, Washington, D. C., at an early date, since the selections will be made about the middle of July.

ACCORDING to a bulletin issued by the Bureau of Statistics the month of May was not, on the whole, very favorable for crop growth, drouthy conditions having prevailed over a great portion of the United States. In consequence the average condition of crop growth in the United States on June 1 was 2.8 per cent. below the average condition on that date. Some relief from the unfavorable conditions came at the close of May and first part of June. A comparison of the conditions of various crops on June 1, with their average growing condition on June 1 of recent years (past ten years for most crops) is shown as follows (100 representing average conditions and not normal): cotton 108.5, sugar beets 103.2, apples 102.5, raspberries 101.8, spring wheat 101.1, watermelons 100.6, pears 99.7, cantaloupes 99.6, blackberries 99.5, sugar cane 99.5, barley 99.2, winter wheat 98.5, rye 98.2, oats 96.9, alfalfa 96.1, onions 95.5, lima beans 92.5, cabbage 91.0, pastures 90.2, hemp 89.0, clover hay 84.6, all hay 85.1, peaches 83.5. The above figures relate only to relative growing conditions, not taking into account changes in acreages. Taking into account both acreage and condition, indications are for about 9.9 per cent. larger wheat crop than was produced last year, and 10.2 per cent. larger than the average of the past five years; oats crop 13.3 per cent. less than last year, but 4.8 per cent. more than the average of the past five years; barley 8 per cent. more than last year, and 5.3 per cent. more than the five-year average. Total areas have not been estimated for the other crops, except that the rye area planted is about 1.2 per cent. less

than last year. Clover (for hay) acreage 6.3 per cent. less and sugar cane acreage 0.4 per cent. more than last year.

UNIVERSITY AND EDUCATIONAL NEWS

The Harvard Medical School has been bequeathed $22,000 by the will of the late Professor Samuel Hubbard Scudder, the eminent entomologist.

Governor Dix has signed a bill that appropriates $235,000 for the state colleges of Cornell University. The Veterinary College receives $140,000 for a new building and $50,000 is appropriated for a heating plant. This bill is independent of the annual bill for maintenance, which has not yet been passed.

At the Bryn Mawr College commencement announcement was made of a bequest of $150,000 from Phoebe Anna Thorne, of New York, who died in 1909, to endow an associate professorship of education and the Phoebe Anna Thorne Model School to be conducted by the college as an experimental high school in connection with a graduate school of education.

Columbia University has received a gift of $10,000 annually for five years from Mr. Charles H. Davis, C.E. ('87), for the support of advanced instruction in highway engineering and Professor Arthur H. Blanchard, of Brown University, has been appointed professor of highway engineering. Among other gifts announced are $45,000 from the committee appointed to raise the Richard Watson Gilder Memorial Fund to establish the Gilder fellowships in good citizenship; $33,133 from the committee appointed to raise the William T. Bull Memorial Fund, to establish a fund for research in surgery, and $20,000 from an anonymous donor for the equipment of the research laboratories in electro-mechanics.

Dr. Eugene A. Noble, president of Goucher College, has been elected president of Dickinson College.

Miss Ellen Fitz Pendleton, dean, acting-president and associate professor of mathematics of Wellesley College, has been elected president of the institution.

Dr. Michael I. Pupin, professor of electro-mechanics in Columbia University, has been designated to serve as director of the Phœnix Research Laboratories. In this capacity, Professor Pupin will be in general charge of the development of the research work in the department of physics.

In the School of Education of the University of Pittsburgh the following appointments have been made: Henry Davidson Sheldon, dean of the School of Education in the University of Oregon, has been made professor of the history of education. Dr. Sheldon will spend next year in Europe on leave of absence and will take up his work in Pittsburgh in the fall of 1912. Charles Barr Robertson, director of the schools of practise and professor of psychology and education in the Cortland, N. Y., State Normal School, has been called to the professorship of secondary education, and will organize and direct the practise teaching and the cooperative relations of the high schools and the university.

The Johnston scholarships, of the Johns Hopkins University, "offered primarily to young men who have given evidence of the power of independent research," have been awarded by Johns Hopkins for 1911–12 to James Ryals Conner, Ph.D., in mathematics; Franklin Edgerton, Ph.D., in Sanskrit, and Joseph T. Singewald, Jr., Ph.D., in geology. The Adam T. Bruce fellowships, bestowed upon candidates who are considered "most likely to promote biological science, and especially animal morphology, by original research," have been awarded to Elmer J. Lund, Ph.B., in botany, and David H. Tennent, Ph.D., in zoology.

Dr. Frederick P. Lord, of Iowa City, formerly connected with the department of anatomy of the State University of Iowa, has been appointed as the head of the department of anatomy of Dartmouth Medical School.

Dr. J. F. Shepard has been promoted from instructor to assistant professor of psychology at the University of Michigan.

A new chair of machine design has been created in the engineering department of the University of Michigan, to which Professor Woldenburg, of Charlottenburg, Germany, has been appointed.

MR. ROBERT NEWSTEAD, lecturer in economic entomology and parasitology in the Liverpool School of Tropical Medicine, has been appointed to the newly-established Dutton Memorial chair of entomology in the University of Liverpool.

DISCUSSION AND CORRESPONDENCE

VITALISM AND EXPERIMENTAL INVESTIGATION

IN connection with the recent helpful discussions of vitalism by Ritter[1] and Lovejoy,[2] one point seems worthy of further emphasis. Some men are interested in science because of its bearing on general philosophical problems; others are interested in philosophical problems because of their bearing on the way to go to work in science. Both attitudes are proper enough; but one's treatment of such a question as vitalism is largely determined by which of these attitudes he takes. The point I wish to emphasize arises from the second attitude. Has vitalism (in any of the brands set forth by Lovejoy) any bearing on the theory and practise of scientific investigation?

This is a practical question in which the experimentalist as such must be interested, even though he may pride himself on his indifference to philosophical speculation. One kind of vitalism appears to me to affect fundamentally the theory of scientific work; for this reason this kind appears of more interest than the other, if not the only kind worth distinguishing.

The man of science at work with his two hands is trying to find the determining conditions for what takes place in matter and energy, and how these conditions act. In so doing he is led to make a study of the various possible methods of work, and particularly of the various ideas and devices that are presented to him as deserving consideration in his work. Many such things come to the worker in biology from outside his own special field; particularly from physics and chemistry. Such were the theories of electric dissociation; much in the physics of colloids, and the like. The biologist is compelled to examine these to see how useful they are in his own experimental analysis; often he finds them of the greatest value, and he modifies his methods of work accordingly.

Various theories of vitalism have likewise been brought to the attention of the investigator, but as a rule he has taken little interest in these, because they seemed of such a nature as not to affect his work; they seemed merely general suggestions and reflections on the fundamental meaning of what one sees in biology, of interest primarily to the man for whom science is the handmaid of philosophy, rather than the reverse. They did not attempt to provide an instrument for actual use in experimentation, nor an idea according to which scientific practise must be altered.

This appears to be the case with the first kind of vitalism distinguished by Lovejoy; a vitalism which holds that there are new modes of action in living things, but that the new modes of action are nevertheless functions of the configuration of the matter and energy involved, so that after we have discovered how a given physical configuration acts, we can depend upon it, as we depend upon such constancy in the inorganic sciences. Such a vitalism involves no fundamental change in our methods of work; we continue to test, by fitting methods, how given configurations act, and to record the results in proper generalizations, exactly as in physics and chemistry. Biology would then, so far as scientific method is concerned, bear the same relation to physics and chemistry that any unexplored part of these sciences bears to the explored parts. The distinction between vitalistic science and physical science would have but a very mild interest for the worker with his hands; it has no pragmatic bearings.

On the other hand, the second kind of vitalism distinguished by Lovejoy makes assertions which would if true require serious consideration in actual practise; indeed, it is put forward by its advocates as supplying certain factors which require consideration on the same grounds as do electric dissociation and osmotic pressure; factors without which our experimental analysis is bound to be incomplete or wrong. Its acceptance would logically

[1] SCIENCE, March 24, 1911.

[2] SCIENCE, April 21, 1911.

produce fundamental changes in the principles of experimentation. This is the point which, to me as an experimenter, seems hardly to receive adequate consideration by Professor Lovejoy; this appears to me the reason why this particular kind of vitalism (the vitalism of Driesch) has received so much attention from investigators, though as a rule they are rather indifferent to vitalistic theory. This is the vitalism which holds that the laws of what occurs in organisms "can not even be stated in terms of the number and arrangement of the organism's physical components."[3] This statement means, if it means anything, that you can not make a statement *which will hold,* that a given arrangement of physical components will act in a certain definite way (even after you have observed how it acts). If such a statement will not hold, this can be only because the same arrangement of physical components acts sometimes in one way, sometimes in another—so that there results indeterminism so far as the physical components are concerned.[4] If vitalism of this sort is correct, then the biologist can not from a knowledge of the total physical configuration predict what will happen, even after he has observed it.

To realize the situation in which this leaves the experimenter, it is needful to consider just what his work consists in. The experimental investigator is engaged in discovering the determining causes of things. Just what we are to understand by *cause* has given rise to much discussion, often leading far away from any experimental concept.[5] Experimentally it means any preceding event or condition without which the event we are studying would not have occurred. Now it turns out in experimentation that everything has a very great number of such "causes," all standing on the same experimental footing, so that to determine "the cause" of any event, taken by itself, is a hopeless task; so taken, the meaning of *cause* becomes undefinable, unless it could be held to signify finding out everything that must have happened in order that this event may occur. Progress can be made only when we so state our problem that we need search for but one determining cause at a time. Now, *one single sufficient experimental cause can be found only for the difference between two cases,* and the actual practise of experimental investigation consists in comparing two cases and finding experimentally what determines the difference between them; discovering, that is, what preceding difference results experimentally in producing the present difference.

An example will make this clear. An organism is observed to move over a certain stretch, from *a* to *b*. What is the cause of this? The question so put opens up a vast perspective; we may go into the production of the energy which brings about the movement, with the infinite number of questions that this involves; we may study the special organs by which this organism performs its movements, and how these organs were produced; we may take up the stimuli which set the organism in motion, and those which determine its direction; the environmental conditions on which the motion depends, etc. All biological science is before us; where shall we take hold? We must make our question precise, and this can be done by considering two differing cases. This specimen now swims in a certain direction; this other (or this same one at a different time) in a different direction. What is the cause *of this difference?* A little experimentation shows that the one, only and sufficient cause is the different direction of the rays of light in the two cases. Or, again, this specimen swims in a certain direction, while

[3] Lovejoy, *l. c.*

[4] A natural result of this is to do what Driesch does and what Lovejoy seems inclined to deprecate; to assume the existence of some non-physical factor, as entelechy, to supply the missing differential determining condition. This grows out of the ordinary procedure in experimental investigation; whether it really helps the experimenter in his work we shall inquire in a moment.

[5] The ambiguities in the word cause have induced some investigators to drop it entirely, and deal only with words having no implication that is not definable in experimental terms; so Verworn in the fifth edition of his "General Physiology."

this other does not, even though the direction of the rays of light is the same. What is the cause of *this* difference? Experiment shows it to be the different temperature in the two cases. In another case the difference in motion is found to be due to difference in chemical conditions; or to difference in the amount of food taken, or the like. Many times we find that there are two or more different factors, any one of which will produce the difference in question; or that the observed difference will not result unless two or more determining factors are combined. These are only details of application; the method throughout is to take two cases differing in a certain respect; then to find the (experimental) determining cause for this difference. By continuing this process, comparing all possible degrees of difference, the causal analysis may be carried to any desired degree of minuteness —till the smallest perceivable differences are reached. The process may be continued backward, tracing step by step how the determining differentials for any given case are themselves determined, until we have as full an experimental analysis as we desire, there being no end to the process of analysis, save as practical considerations compel us to stop.[6]

The investigator may of course not always actually have the two cases present before him; he may not even think of the concrete existence of more than one of the cases, but the rationale of the process, when analyzed, is that which we have set forth.[7]

Now, the fundamental principle on which this work of the investigator is based is this: *When two cases differ in any respect, there will always be found a preceding difference to which the present difference is* (experimentally) *due.* This principle is, explicitly or implicitly, constantly present with the experimenter. If two experiments, supposedly alike, give different results, *there must be some preceding difference to account for this.* The investigator is so convinced of this that it does not occur to him to doubt it or state it or consciously raise the question at all; he merely sets to work to find what the difference is, and he may spend hours or days or years in his search. This principle is the air the experimenter breathes, the water he drinks and the food he takes. It is what makes him an experimenter. If he should become convinced that it does not hold, the logical thing for him to do is to follow the finely consistent example of the sponsor for the kind of vitalism that asserts that it does not, and drop experimentation to take up philosophy.

The question whether this principle is correct need not concern us now; what I wish to bring out is the tremendous difference in scientific investigation in two fields, in one of which this principle holds (as it is supposed to do in physics and chemistry), while in the other it does not (as in biology, according to this sort of vitalism). The investigator in the field where it does not hold would be continually in doubt as to what to do. Here are two experiments that result differently. But is it worth while to search for an experimental determining factor for this difference? Perhaps there is no such factor—for this is biology, not physics. The guiding principles are different in the two fields; while we might in physics be certain that an experimental cause could be found for the difference, in biology we can not, for in biology the same configuration may give sometimes one result, sometimes another. This is a difference in principle that would really make it worth while to separate the two sets of sciences in a fundamental way; this would give us a vitalism that had some practical consequences.

But what should be the further procedure of the biologist in view of the fact that two complexes absolutely identical in their phys-

[6] The farther work, of comparing the results of this analysis and recording them in fitting generalizations, by which the heap of facts is reduced to an ordered whole, does not concern us here.

[7] Thus, when the investigator merely asks: What determines the *direction* of this movement—the experimental question essentially is, When this specimen moves in a certain direction, while another does not, what determines the difference between the two cases? Neglect to analyze problems into this form leads to much of the inconclusive work and difference of opinion in experimental biology.

ical[8] make-up give different physical results? Shall he abandon the principle of "univocal determination," not merely from a practical experimental standpoint, but completely? Or shall he follow Driesch's example and try to save the principle by assuming that the two cases differ in something non-physical (which he may call entelechy if he likes the word)? Professor Lovejoy's suggestion that this latter is a hypostasis hardly warranted in strictly scientific procedure, would leave us absolutely without determining cause for the difference; the experimenter could but admit the failure of the principle on which his work is based, lay down his arms, and surrender. But does Driesch's assumption of a non-physical differentiation between the two cases leave the experimenter in a better situation?

Driesch's statement to save the principle of determinism in such a case is as follows: "given certain circumstances, and given a certain entelechy in a certain state of manifestation, there will always be or go on one specifically determined event and no other."[9] Thus under the conditions we have sketched, the investigator could comfort himself (if he found it a comfort) with the assertion that different entelechies were at work in the two cases; or that the same entelechy was at work in different manifestations (the latter formula would be forced upon us by the vitalistic arguments from behavior). Now, what is the difference between attributing experimental results to such non-physical determiners, and the ordinary experimental procedure of attributing them to physical determiners?

The difference lies in two points (which are perhaps fundamentally one): (1) Any physical factor has various manifestations, the conditions for each of which are discoverable and constant; it is bound up in many different ways with the rest of the conditions. Hence if the experimenter attributes a result to a certain physical factor, this is at once open to test; we may try whether its other manifestations appear as they should if it is in presence; it leads at once to farther experimentation, and the explanation must stand or fall in accordance with the results of this experimentation. On the other hand, the non-physical entelechy may give different manifestations (or none at all) under the same conditions; there is no way that we can test the affirmation that a given experimental result is due to it. A physical factor that showed itself in one unique manifestation, and might later show itself under the same conditions in a different manifestation would of course leave the experimenter as helpless as does entelechy; but such a "physical factor" is a contradiction in terms; it is because entelechy has this character that it is a non-physical factor.[10] Thus attribution of a result to entelechy closes the door to farther experimental test.

2. In experimenting in non-vitalistic fields, after we have discovered what preceding differences determine (experimentally) our given diversities, we may move a step back and discover in the same way what determined those preceding differences; and this process of carrying back the experimental analysis is without end (save from practical difficulties). On the other hand, as soon as the experimenter has attributed his observed diversities of result to different manifestations of entelechy he is at the end of his experimental rope. What determines, under the same physical conditions, the different manifestations of entelechy? The problem is not only practically, but by hypothesis, beyond the reach of experimentation.[11]

[8] I am throughout using the word *physical* in place of "physical and chemical," "physical or chemical" and "physico-chemical."

[9] "The Science and Philosophy of the Organism," II., 153–154.

[10] If, as some have suggested, entelechy is to be considered merely a name for a factor whose dependence on the rest of the conditions and whose uniformity of action is not yet known, we should of course by this assumption drop our vitalistic theory; it is by vitalistic hypothesis that entelechy has the peculiarities mentioned above.

[11] "Organic systems are governed by entelechy, and therefore contain all possible future perceptible diversities in an *imperceptible* form," Driesch, "Science and Philosophy of the Organism," II., 198.

Thus the bringing in of entelechy as a determiner is at most a pad to soften the experimenter's fall; a way of distracting his attention for a moment from the dolorous fact that his method of work has failed. It merely puts off for one single step the admission that the principle on which experimental investigation is based breaks down when applied to biology. Physical science and vitalistic science are then distinguished by a fundamental difference in the principles of investigation, of the highest practical consequence.

Some attempts are made to console the biological experimenter for this difficulty; to make light of the difference in investigation in the two fields. Professor Lovejoy comforts us by saying that, in the case of the developmental processes on which Driesch partly bases his argument, you could "if you go back to an early enough stage in the given sequence of processes" find "perfectly definite, perceptible and experimentally ascertainable constant antecedents" for the observed procedure; this in view of the fact that men do not gather figs of thistles, nor whales of sea urchin's eggs; to get a given type of adult you must at least have the egg of that type. Thus only that immense field of developmental processes which lies between the egg and the adult would be exempted from experimental determinism! This might yield some solace to those whose life work does not lie in this field, were it not that Lovejoy quite leaves out of account Driesch's arguments and conclusions for the other fields of animal activities, particularly for behavior. In behavior, according to Driesch's vitalism, what the animal does depends as much on the non-physical entelechy as it does in development, and yet there is no single type toward which each act tends.[12]

Again, some have assured the writer that we may accept this kind of vitalism and still go ahead with our work just as if experimental determinism still held; that in fact cases where it doesn't hold probably occur only under rare and recondite conditions, which we may never meet. This vitalism, reserved like the religion of some individuals for Sunday consumption only, receives no encouragement from any close examination of vitalistic theory. Taking as an example Driesch's working out, we find that we may expect the vitalistic factor to show its action continually in all sorts of work with living things. According to Driesch the precise work of the vitalistic factor is to "suspend for as long a period as it wants any one of all the reactions that are possible with such compounds as are present, and which would happen without entelechy. And entelechy may regulate this suspending of reactions now in one direction and now in the other, suspending and permitting possible becoming whenever required for its purpose. . . . This faculty of a temporary suspension of inorganic becoming is to be regarded as the essential ontological characteristic of entelechy."[13] That is, when there are in juxtaposition a number of substances which, according to purely chemical laws, would interact, giving certain results, entelechy may (or may not) interfere, preventing the union of certain of these, until the resulting products are determined by those that have been allowed to interact. Thus from the same mixture of chemicals we shall get sometimes one product, sometimes another (depending on the purposes of entelechy); the variety of results thus obtainable from a given complex is of course very great. Now, all living things are complexes of great numbers of

[12] Thus Professor Lovejoy can not be followed when he states that "All that Driesch maintains is that such a [morphogenetic] process once started continues toward its normal consummation even if, after the start, some of the usual machinery instrumental to the consummation is lost and the rest has to redistribute and redifferentiate itself in order to keep things moving in the customary manner." This is only one of the observed facts on which Driesch bases his vitalistic theory; he has published an entire book on vitalism in behavior, and a large proportion of "The Science and Philosophy of the Organism" is devoted to the same subject. One gets a very inadequate idea of the real nature of his theory by supposing it limited to morphogenesis; his conclusions reach far beyond this.

[13] "The Science and Philosophy of the Organism," II., 180.

chemicals, so that the condition under which entelechy comes into play is always realized. We may therefore expect its action at any step in our work; we must be prepared at all times to find the same physical configuration giving rise now to one result, now to another; we can have no confidence that when two experiments give different results, it will be possible to find an experimental cause for this difference.

Doubtless there are investigators who can persuade themselves that they really believe this sort of thing, and yet who can continue hopefully their hopeless task of trying to discover experimentally the conditions that determine what happens—just as there are persons who assert that they believe certain orthodox religious doctrines and yet live cheerfully the life of the worldly. But for one who takes his experimental work seriously and who has use for theories only as *theories of practise*, the acceptance of such a doctrine can not fail to profoundly change his work and his attitude toward his work.[14] It takes away the guiding principle on which every step of his work is based.

Thus a doctrine which holds to consistent physical determinism in the inorganic sciences and rejects it for biology makes a tremendous difference in principle between the two fields; a difference big with practical results. I believe that to most working investigators of biology the question of vitalism means the question whether there is such a difference, and it appears unfortunate that this question should be obscured by confusing it with the (for the working investigator) relatively inconsequential question as to whether anything happens in living things that doesn't happen in those not alive.

H. S. Jennings
Johns Hopkins University,
May 16, 1911

[14] Of course there would still be work for the biologist. Descriptive and observational work would be little affected. The biologist could substitute "entelechy" for "god" or "providence" or "nature" in the pious expositions of the naturalists of two generations ago, and devote himself to showing the wonderful and unfathomable ways of entelechy. If of an incurably analytic turn of mind he could even examine the limitations which the physical conditions place upon entelechy: and perhaps make a catalogue and classification of the various results produced by entelechy from a given physical configuration. It is the principles, methods and objects of experimentation that would be changed.

THE APPLICATION OF THE METHOD OF LEAST SQUARES

To the Editor of Science: It would, I think, be interesting and valuable to have a consensus of opinion from both astronomers and physicists as to the limits within which the application of the method of least squares is permissible. This method is used widely by astronomers and but rarely by physicists. Moreover, I believe most physicists would hesitate to push the application of the method as far as is commonly done by astronomers.

To take a concrete case: During the discussion that followed the Saturday afternoon symposium at the recent general meeting of the American Philosophical Society, one point under discussion was whether or not the principle of relativity requires the abandonment of the concept of the ether. The writer mentioned as an *experimentum crucis* the possibility of detecting an ether-wind by measuring the speed of light in a single direction and over a path which for its greater part lay remote from the surface of the earth, thus avoiding a limitation of the Michelson-Morley experiment. It was suggested that if the measurement of the speed of light by Römer's method could be carried out with sufficient accuracy, and at two such times that the light would have to travel with and against the proper motion of the solar system, such an ether-wind might be observed. It was pointed out that the difference of time to be expected would be of the order of one fifteenth of a second. Some doubt was expressed as to whether this accuracy was yet attainable in a difficult measurement of this nature.

To this Professor Pickering replied that a large mass of such data was already in the possession of the Harvard Observatory, and had been discussed and reduced with this very

point in mind, and with a negative result. In response to a query from Professor Doolittle as to the precision of the observations Professor Pickering stated from recollection that the error of a single observation might be three or four seconds, but that the hundreds of observations available brought the probable error well within the precision required.

It seems to me there is room for an honest difference of opinion as to the value of the method of least squares in a case like this, where the error of a single observation may be forty-five or more times as great as the quantity to be detected. Surely we must draw a line somewhere.

While I have given this point no extended investigation, I may formulate my own opinion, as a basis for discussion, in the form of a mathematical theorem:

The value of the measure of precision obtained by applying the method of least squares varies inversely as the ratio e/q (where $e =$ error of a single observation and $q =$ quantity to be measured), in such a manner that when $e/q = 1$ the value is zero, and for $e/q > 1$ the value is wholly imaginary.

PAUL R. HEYL

DR. BRUSH'S THEORY OF GRAVITATION

TO THE EDITOR OF SCIENCE: The article by Dr. Brush on "A Kinetic Theory of Gravitation" in SCIENCE of March 10, will become of great interest to physicists when the author does what he partly promises to do in a future paper, viz., explains how a body which is perfectly transparent to a given radiation can shield another body from that radiation, and why, if the other body is also perfectly transparent, it makes any difference whether it is shielded from the radiation or not. It would appear to be immaterial, so far as the effect upon the body is concerned, whether the atoms of a body through which this radiation is streaming in all directions are "buffeted about in every direction by the ether waves in which they are entangled" or whether they remain undisturbed by these waves, so long as they do not absorb any energy from the radiation.

Dr. Brush says that in the former case, "Each atom or molecule may be regarded as a center of activity due to its kinetic energy of translation, with continual absorption and restitution of the ether's energy normally equal in amount." This seems to the present writer equivalent to saying that a perfectly transparent body may be regarded as one in which the atoms are continually absorbing and radiating equal quantities of the same kind of energy. If anything can be gained by making such an assumption, there seems to be no objection to making it, and I, for one, shall look forward with interest to Dr. Brush's explanation of how it will enable such a transparent body to cast a shadow.

FERNANDO SANFORD

STANFORD UNIVERSITY

SCIENTIFIC BOOKS

Soil Fertility and Permanent Agriculture. By CYRIL G. HOPKINS, University of Illinois. Pp. xxiii + 653; 14 illustrations, 3 colored maps. Boston, New York and London, Ginn & Co. Price $2.50.

Of this work the author says: "The chief purpose of this volume is to bring together in convenient form the world's most essential facts, gathered from the field and laboratory, and to develop from them some foundation principles of permanent agriculture." The book is a notable contribution to the foundations of practical agriculture, treated in an introduction and four parts, I., Science and Soil; II., Systems of Permanent Agriculture; III., Soil Investigations by Culture Experiments; IV., Various Fertility Factors.

The method of treatment adopted is admirable but not that usually chosen by writers on either soil or agricultural chemistry. The book takes a distinct place in agricultural literature and will be found a mine of information and valuable reference to the subjects it treats. Professor Hopkins holds persistently throughout the volume to the thesis named in the title and does not aim to treat in detail a wide range of topics, but has built his treatment upon a broad, most substantial

foundation of germane data, thoroughly and logically cemented. The 121 tables of foundation data are mostly the results of well conceived, long continued, carefully measured and verified experiments, executed both in Europe and in this country. They are not only put into effectively illuminating form by the author and discussed, for his purpose, with good discrimination, but they will be found most valuable references for many other purposes.

Some will question the wisdom of recalculating the data of some of these tables on the basis of the elements but there can be no doubt that this method serves much better for comparative study, and had earlier investigators adopted the plan no serious criticism would be urged. We feel that the author should have gone a step farther and expressed all results on the basis of weight, and of dry weight, wherever possible. The amounts of plant food elements and of water removed from the soil by a bushel of potatoes, oats and wheat have no proper comparative relation, as they do when expressed on the basis of dry substance.

Within the last few years there has been such a pronounced growth of public appreciation regarding the importance of the maintenance of soil productivity that plant physiologists, pathologists and geologists, with others, are following the lead of bacteriologists in efforts to see if in their fields there may not exist relations which will enable their observations to shed important light on the complex problems involved. This is progress along hopeful lines and such investigators may feel that the volume before us does not give sufficient prominence to these newer lines of research. But as Professor Hopkins has written for the educated farmer, and from the standpoint of every-day field practise, he has wisely chosen not to obscure that which has been proven by prolonged careful research, checked by practical experience, with the presentation of theories suggesting practises not yet tried, which may or may not prove helpful.

Ten chapters are devoted to science and soil, in which fundamental facts and principles are stated, followed by presentations regarding plant food elements and compounds; plant food and the earth's crust as an original source; and soil formations and classifications, two maps being given, one for Illinois and the other for the United States. The composition of soils in general is treated, followed by that of soils of eastern, central, northern, southern and western United States, expressing the results in amounts contained in two million pounds of dry surface soil, or approximately that contained in an acre to the usual depth of plowing. Ten residual soils of Maryland are shown to carry 720 to 1,500 pounds of phosphorus, while the Illinois soils range between 810 and 2,030 pounds per two million pounds of dry soil. These amounts Professor Hopkins considers would be removed by approximate maximum crops in a rotation of wheat, corn, oats and clover in from 37 to 105 years; or if only the grain is sold, in from 68 to 192 years.

It is highly probable that no normal soil can experience the withdrawal of any considerable proportion of its phosphorus without suffering material reduction in producing power, and if so, even if it be true that the phosphorus in the second, third and fourth feet participates equally and continuously in crop production, permanent agriculture with undiminished yields must be impossible except through restoration in some manner. Professor Hopkins considers that usually there is no natural process of restoration sufficient to maintain high yields, and closes the first part, only after considering crop requirements for nitrogen, phosphorus and potassium, together with sources of plant food, thus providing quantitative data for the discussion of systems of permanent agriculture, treated in seven chapters.

In introducing the subject he says:

> For practically all of the normal soils of the United States, and especially for those of the central states, there are only three constituents that must be supplied in order to adopt systems of farming that, if continued, will increase, or at least permanently maintain, the productive power of soil. These are *limestone, phosphorus* and *organic matter*. The limestone must be used to

correct acidity where it now exists or where it may develop. The phosphorus is needed solely for its plant food value. The supply of organic matter must be renewed to provide nitrogen from its decomposition and to make available the potassium and other essential elements contained in the soil in abundance, as well as to liberate phosphorus from the raw mineral phosphate naturally contained in or applied to the soil.

It should be said here that throughout the work Professor Hopkins is concerned only with general farming, not with intensive agriculture where other fertilizers can be used with profit and must be if largest results are secured.

Chapters are given to the discussion of limestone, of phosphorus and of organic matter and nitrogen, as to their function, quantitative needs and maintenance. Then follow chapters on rotation systems for grain farming, live stock farming, the use of phosphorus in different forms and finally theories concerning soil fertility. The subject-matter of these chapters is of the greatest importance; the views presented are in the main fundamentally sound; they are well presented, and must have a very important influence in advancing agriculture in the United States.

Part III. contains an admirable digest of the more important field experiments bearing upon permanent agriculture, conducted at Rothamsted, England; in Pennsylvania, Ohio, Illinois, Minnesota, in the south and in Canada, pointing out their bearing upon the views expressed in the preceding sections.

Professor Hopkins has succeeded in producing a worthy companion volume to Hilgard's great work "Soils."

F. H. KING

MADISON, WIS.,
May 16, 1911

The Ice Age in North America and its Bearing upon the Antiquity of Man. By G. FREDERICK WRIGHT. Fifth edition, revised and enlarged. Pp. 800. 200 illustrations. 8vo, cloth.

The popularity of Wright's "Ice Age" is sufficiently attested by the fact that the fifth edition is now published under date of December 22, 1910, enlarged and embellished with many new and interesting illustrations.

The value of Professor Wright's work consists principally in the illustrations and descriptions he gives of glacial phenomena not only in North America, but in other portions of the world. The main criticism of this work, which has many good features, is that its author is too credulous, and has thus permitted many exploded "chestnuts" like the "Calaveras Skull," the "Lansing Skeleton" and the "Nampa Image" to find in him a defender of their antiquity. This tendency of Professor Wright is unfortunate, since it of itself throws doubt upon his power of critical discrimination in analyzing evidence pro and con in matters of geologic controversy. It is possible that Professor Wright's theological beliefs have unconsciously biased his judgment in matters pertaining to the age of the earth, and to the date of the glacial epoch. In spite of these defects, however, Professor Wright's "Ice Age in North America" will prove a useful work in enlisting popular attention, and study of these most interesting phenomena connected with the Pleistocene glaciation.

I. C. WHITE

SPECIAL ARTICLES

A SCALE FOR MEASURING THE MERIT OF ENGLISH WRITING

ONE inch may be said to be equal to another inch from any one of three lines of evidence. If the two are compared by a hundred experts, (1) the experts will all report the two as indistinguishable; or (2) if some of them do, by microscope, micrometer or the like, find a difference of a trifle plus or minus, the number finding the first inch plus will equal the number finding it minus; or (3) if each man is forced to report a difference, half will find the first inch plus and half minus.

One specimen of English writing may be said to be equal to another from the second or third lines of argument, the only logical difference between equating the two lengths and equating the two specimens of writing being that the variability of expert judges in the

latter case is so great that we never find all of them, and rarely find many of them in agreement, as to the indiscernibility of any difference. But specimens 571 and 220 below are, in merit as defined by, say, 100 competent persons, approximately equal, since if asked to report 571 as better, equal to, or worse than 220, there will be a large proportion of equals and the judgments "better" will approximately equal the judgments "worse." Of 110 competent persons, forced to make a distinction, 54 favored sample 571 and 56 sample 220.

571. VENUS OF MELOS

In looking at this statue we think, not of wisdom, or power, or force, but just of beauty. She stands resting the weight of her body on one foot, and advancing the other (left) with knee bent. The posture causes the figure to sway slightly to one side, describing a fine curved line. The lower limbs are draped but the upper part of the body is uncovered. (The unfortunate loss of the statue's arms prevents a positive knowledge of its original attitude.) The eyes are partly closed, having something of a dreamy langour. The nose is perfectly cut, the mouth and chin are moulded in adorable curves. Yet to say that every feature is of faultless perfection is but cold praise. No analysis can convey the sense of her peerless beauty.

220. GOING DOWN WITH VICTORY

I sat on the top of a mail-coach in Lombard street impatiently awaiting the start. 'Twas the the night of the victory and we would help spread the news over England.

Up jumps the coachman followed by the guard, an instant's preparation, a touch of the lash and we are off! We are soon past the limits of the city out in open country, galloping, tearing along, a clear road ahead of us for the English Mail stops for nothing.

We dash in at villages, stopping but a moment with the mail, shouting the news of the victory and we are off again. Proud were we and had we not a right to be? The first to carry the great news through the land!

The memory of that ride is ever fresh in my mind and I will ever remember those hours as the most glorious in all my life.

The difference between 1 inch and 2 inches is said to be equal to the difference between 2 inches and 3 inches, because the experts will, as before, all agree or divide equally in their disagreement. The essential logic of their procedure will appear if we change the illustration.

Let their task be to examine the following pairs of lengths: I. (*a*) 10.0000 inches, (*b*) 10.0001 inches, II. (*c*) 10.0001 and (*d*) 10.0002, III. (*e*) 10.0001 and (*f*) 10.0003, IV. (*g*) 10.0001 and (*h*) 10.0004, V. (*i*) 10.0001 and (*j*) 10.0005, and to judge in each case whether the second line of the pair is shorter, equal, or longer. We shall find that even the experts make some wrong judgments with these very small differences, but that the proportion of right judgments increases as the difference increases, so that we can conclude that the difference between (*a*) and (*b*) is equal to the difference between (*c*) and (*d*), not because it is always judged so, but because it is *equally often* judged so, by experts. The basis for the scientific acceptance of a difference may then be that judgments of longer are more frequent than judgments of shorter. And the basis for the scientific acceptance of one difference as equal to another difference may be that the preponderance of judgments of longer is equal in the two cases. This is not the whole truth of the matter in the case of the equality of such differences as 1.0001 in.–1.000 in. and 1.0002 in.–1.0001 in.; but it is a part of it.

This part of it may be made true of judgments of differences in merit in English writing. For instance Specimen 627 is judged to have more merit as writing by young people in their teens than specimen 570 by 83 out of 110 competent persons. Specimen 570 is also judged to have more merit, similarly defined, than Specimen 603 by 82 out of the same 110 competent persons. The difference between Specimens 627 and 570 is then approximately equal to the difference between Specimens 570 and 603.

627. A SCENE

I think the sunlight is very beautiful on the water, and when it shines on the water it is very beautiful, and I love to watch it when it is so beautiful. The colors are so pretty and the noise

of the water with the sunshine are so attractive in the sunshine I wonder do other people love to watch the water like I do. I don't know as there is anything as lovely as the water waves in the sunlight of the glorious orb.

570. DESCRIPTION OF SCHOOL ROOM

Our school room is on the side of the school house and it is a awfully nice room and I like it because it is so nice and all the boys like it, there is a good many pictures on the wall and there is a clock on the wall. We like this school room and come to school most all the time.

603. A CHARACTER SKETCH

The man I am describing is a white man and he has nice hair and wears a hat, and his horse is black, I like this man and he has two eyes and his nose is red.

In this way it would be possible to discover specimens of English writing ranging from Specimen 607 (which may roughly represent zero merit in English writing by young people in their teens) up to the best writing known, by equal steps, so that Specimens 0, 1, 2, 3, 4, and so on, would have in part, the significance for merit in English writing that 0 inch, 1 inch, 2 inches, 3 inches, and so on have for length.

607. SKETCH

I words four and two came go billa guni sing hay cows and horses he done it good he died it goon I want yes sir yes sir oxes and sheeps he come yes sir camed and goes billum gumun oomunn goodum.

Such a series of specimens representing defined degrees of merit in composition would be of service to civil service examiners, college entrance examination-boards, high-school teachers of English, and any others who were concerned with measuring ability to write English, the changes produced in that ability by various forms of training, or the differences in it that distinguish certain groups.

An investigation designed to establish such a scale is now being made by Mr. M. B. Hillegas and myself. We should be very glad if any of the readers of SCIENCE would cooperate to the extent of sending us their ratings of the ten specimens printed below. All that is required is that the reader consider these as specimens of English writing by young people, choose the one that seems to him to have the least merit, number it 1, choose the one that has next least merit, number it 2, and so on, and send the record to M. B. Hillegas, Bureau of Education, Washington, D. C., or E. L. Thorndike, Teachers College, Columbia University, New York. For this purpose the following slip may be used:

I rank specimen 94 as
" " 196
" " 200
" " 300
" " 323
" " 434
" " 519
" " 520
" " 534
" " 627

Signed. .....

94. SULLA AS A TYRANT

When Sulla came back from his conquest Marius had put himself consul so sulla with the army he had with him in his conquest siezed the government from Marius and put himself in consul and had a list of his enemys printy and the men whoes names were on this list we beheaded.

196. ICHABOD CRANE

Ichabod Crane was a schoolmaster in a place called Sleepy Hollow. He was tall and slim with broad shoulders, long arms that dangled far below his coat sleeves. His feet looked as if they might easily have been used for shovels. His nose was long and his entire frame was most loosely hung to-gether.

200

My dear Fred,—

I will tell you of my journey to Delphi Falls, N. Y. There is nice scenery along this route. The prettiest scene is in the gulf which is quite narrow, a small creek flows down it and the road follows along near its banks.

There are woods on either side, these trees look very pretty when they are white with snow.

In summer it is always shady and cool in them and the small fish may be seen darting back and forth in the water.

I hope I will have the pleasure of taking you over the route some time.

Yours sincerely,

300. THE PREACHER OF AUBURN

The most popular man of Auburn was the preacher. Although he had a very small salary he was contented. The preacher was kind to everybody. Little children loved him. Old soldiers liked to sit by his fireside and tell stories of the battles, which they had fought in. The beggars who came to his door, although chided for leading such an existence, were always clothed and feed.

The preacher was always willing to go to the homes where there was sickness or death. Here he helped in all things that he could.

In the church he preached with unaffected grace, and all who came to scoff at him remained to worship.

The minister was a contented, simple and kind man, whom the people loved.

323. ESSAY ON BURNS

As far as I can learn from the Essay on Burns, Mr. Carlyle considers that good poetry must contain the sincerity of the poet. The poem must show the author's good choice of subject and his clearness of sight. In order to have good poetry the poet must be familiar with his subject and his poem will show it.

The characteristics of a great poet, in Mr. Carlyle's opinion were sincerity and choice of subjects. A poet must be appreciative of nature and have a responding heart. Carlyle says a true poet does no have to write on subjects which are far away and probably come from the clouds. A truly great poet makes the most of subjects which are familiar to him and close to earth, as Burns did in his poems to the Field Mouse and to The Daisey.

434. A DIARY

I had an early run in the woods before the dew was off the grass. The moss was like velvet and as I ran under the arches of yellow and red leaves I sang for joy, my heart was so bright and the world was so beautiful. I stopped at the end of the walk and saw the sunshine out over the wide "Virginia meadows."

It seemed like going through a dark life or grave into heaven beyond. A very strange and solemn feeling came over me as I stood there, with no sound but the rustle of the pines, no one near me, and the sun so glorious, as for me alone. It seemed as if I felt God as I never did before, and I prayed in my heart that I might keep that happy sense of nearness all my life.

519. DE QUINCY

First: De Quincys mother was a beautiful women and through her De Quincy inhereted much of his genius.

His running away from school enfluenced him much as he roamed through the woods, valleys and his mind became very meditative.

The greatest enfluence of De Quincy's life was the opium habit. If it was not for this habit it is doubtful whether we would now be reading his writings.

His companions during his college course and even before that time were great enfluences. The surroundings of De Quincy were enfluences. Not only De Quincy's habit of opium but other habits which were peculiar to his life.

His marriage to the woman which he did not especially care for.

The many well educated and noteworthy friends of De Quincy.

520. A CHARACTER SKETCH

They were in fact very fine ladies; not deficient in good humour when they were pleased, nor in the power of being agreeable when they chose it, but proud and conceited. They were rather handsome, had been educated in one of the first private seminaries in town, had a fortune of twenty thousand pounds, were in the habit of spending more than they ought, and of associating with people of rank, and were therefore in every respect entitled to think well of themselves, and meanly of others.

534. FLUELLEN

The passages given show the following characteristic of Fluellen: his inclination to brag, his professed knowledge of history, his complaining character, his great patriotism, pride of his leader, admired honesty, revengeful, love of fun and punishment of those who deserve it.

627. A SCENE

I think the sunlight is very beautiful on the water, and when it shines on the water it is very beautiful, and I love to watch it when it is so beautiful. The colors are so pretty and the noise of the water with the sunshine are so attractive in the sunshine I wonder do other people love to watch the water like I do. I don't know as there is anything as lovely as the water waves in the sunlight of the glorious orb.

EDWARD L. THORNDIKE

TEACHERS COLLEGE,
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SEX-LIMITED INHERITANCE AND SEXUAL DIMORPHISM IN POULTRY

WHEN a Barred Rock hen is bred to a non-barred, *e. g.*, black, cock, all the female offspring are non-barred, all the male barred. This generation, then, is sexually dimorphic. The offspring of the reciprocal mating is not dimorphic, since all the offspring are barred. For reasons which will appear in a moment, I wish to repeat the usual formulæ for this case; B standing for barred; b for non-barred, *e. g.*, uniform black.

Barred Rocks: male, B♂ B♂; female, B♂ b♀.
Non-barreds: male, b♂ b♂; female, b♂ b♀.
A. Barred females by non-barred male gives in F_1,
barred males, B♂ b♂; gametes, B♂ b♂;
and non-barred females, b♂ b♀; gametes, b♂ b♀.
Inbred they give in F_2, barred males, B♂ b♂;
non-barred males, b♂ b♂;
barred females, B♂ b♀;
non-barred females, b♂ b♀.
B. Non-barred females by barred male give in F_1,
barred males, B♂ b♂; gametes, B♂ b♂;
and barred females, B♂ b♀; gametes, B♂ b♀.
Inbred they give in F_2, barred males, of two sorts, viz., { B♂ B♂; B♂ b♂;
barred females, B♂ b♀;
non-barred females, b♂ b♀.

Now barring is a dominant character. If, however, it is treated as a recessive, *i. e.*, patent only in the homozygous condition, some suggestive results follow. In the first place the Barred Rocks become sexually dimorphic in respect to barring, for the male, being homozygous, will be barred, but the female being heterozygous will be non-barred. Moreover, this dimorphism will continue indefinitely in succeeding generations.

When this hypothetical dimorphic breed is bred reciprocally to a uniform black breed, all the F_1 offspring will be non-barred and the usual signs of sex-limited inheritance will be lacking. The F_2 generation, as shown under A, will all be non-barred, and of those under B only one fourth will be barred and these all males.

This hypothetical case offers a plausible explanation of the mode of inheritance of sexual dimorphism. However, this case, while possible, is probably simpler than any likely to be encountered in actual experience. Moreover, the greater the number of different factors involved, the more the observed ratios will obscure the hypothetical ratios.

The following experiments are interesting in this connection:

First may be recorded the results of crossing Brown Leghorns and Buff Plymouth Rocks. The former's plumage or some of its elements is known to follow a sex-limited mode of inheritance. Of the mating Buff Rock females by Brown Leghorn male only chicks in the down are on hand, but they are exactly like the chicks of the reciprocal mating. The adults of this last mating are reddish buff in both sexes without the usual features of sex-limited inheritance. In F_2 true buffs appeared and various other colors (among them the Rhode Island red color) but no true Brown Leghorns. The detailed theoretical formulation must await the results of other matings, but compare under A above. Chicks in the down of the mating F_1 female by Buff Rock male are on hand. None of these, unlike many of the F_1 chicks, are striped. The absence of striped chicks indicates an absence of the heterozygous form.

In the second place are to be recorded the results of castration experiments on young Brown Leghorns. Though not yet old enough to show all the adult characters, the castrated males are assuming the male juvenile plumage, which, it should be noted, is almost as sharply differentiated from the female's juvenile plumage as the adult male's is from the adult female's. The castrated females, on the contrary, have already assumed a considerable part of the male's juvenile plumage.

These experiments indicate that a recessive character, sex limited in inheritance, can, according to the formulæ given above, be utilized in an explanation of the mode of inheritance of sex dimorphism. On the other hand, a dominant sex-limited character, at least in poultry, does not lead in this direction.

While it is probable that the plumage of the male Brown Leghorn is a homozygous recessive, and the female heterozygous, it is

not certain what the dominant element or factor is. It may be female Brown Leghorn color, a modifier, or femaleness or something else. As females colored nearly like Brown Leghorn females appeared among black females in F_1 from Brown Leghorn males by White Rock females it suggests that the dominant element is not female color.

A similar inference may be drawn from the distribution of color in the buff and black non-barred F_1 females from White or Barred Rock females by Buff Rock male. Some of these are black with orange hackle and grade into others in which buff predominates. In all cases the colors are distributed in a more or less perfect imitation of the pattern of Brown Leghorn females. Moreover, many of these hybrids are stippled in certain regions which always correspond to the regions in Brown Leghorns which are stippled.

H. D. Goodale

"Oakwood,"
Stamford, Conn.

THE NORTH CAROLINA ACADEMY OF SCIENCE

The tenth annual meeting of the North Carolina Academy of Science was held at the Agricultural and Mechanical College, Raleigh, on April 28 and 29, 1911, with an attendance of forty members. The meeting of the executive committee, held in the early afternoon of April 28, was followed by a general meeting for the reading of papers. At night, after the academy had been welcomed to the Agricultural and Mechanical College by President D. H. Hill, the retiring president of the academy, Professor W. H. Pegram, delivered his presidential address, "The Problem of the Constitution of Matter." Following this, Professor John F. Lanneau gave a lecture on "Sirius: the Bright and Morning Star."

On Saturday morning, April 29, the annual business meeting was had. Reports of the secretary-treasurer and of the various committees were made. Five new members were elected. These together with the present membership of 80 give a total of 85 members. The report of the secretary-treasurer showed that the academy in membership, in the interest shown in its work, and in its finances, was in better condition than at any time during its history.

The following officers were elected for the ensuing year:

President—H. V. Wilson, University of North Carolina, Chapel Hill.

Vice-president—W. A. Withers, Agricultural and Mechanical College, West Raleigh.

Secretary-treasurer—E. W. Gudger, State Normal College, Greensboro.

Executive Committee—J. J. Wolfe, Trinity College, Durham; Franklin Sherman, Jr., Department of Agriculture, Raleigh; Andrew H. Patterson, University of North Carolina, Chapel Hill.

At 10 A.M. the academy and the North Carolina Section of the American Chemical Society held a joint meeting at which Dr. R. A. Hall, of the University of North Carolina, read a report on "The Chemical Researches of Ehrlich Leading to '606.'" Following this, reading of papers on the academy program was resumed. At 2 P.M., the program being finished, the academy adjourned to the dining room of the college, where a luncheon was given complimentary to the visiting members.

The total attendance was forty out of a membership of eighty-five. There were thirty-three papers on the program, all of which were read save two, and all read when called for but two. In attendance, number of papers presented, general interest as evidenced by the discussion of the papers, this session excelled any in the history of the academy. In addition to the presidential address, which is published in full in the current number of the *Journal of the Elisha Mitchell Scientific Society*, and to the lecture on Sirius, the following papers were presented:

Catching Hawk Moths on Flowers at Dusk: C. S. Brimley, Raleigh.

This paper tells the author's experiences in catching hawk moths on flowers at dusk in several years at Raleigh, N. C. The flowers first experimented with were jimson weed, afterwards four-o'clocks. With the jimson weeds it was found that tying the flowers in bunches was an advantage, while this did not apply to the four-o'clocks, as they were already in bunches. Two flights of moths were noted, the first in June, the second in July and later, the latter largely, the former wholly composed of moths from over-wintering pupæ. The proportion of sexes visiting flowers was 5 males to 2 females. A neighbor's cat was found to be as expert a catcher of hawk moths on flowers as the author. The notes apply mainly to the two tobacco hawk moths.

To be published in full in the current number of the *Journal of the Elisha Mitchell Scientific Society.*

Natural History Notes: E. W. GUDGER, State Normal College, Greensboro.

A. *An Interesting Case of Symbiosis* (specimens exhibited).—For six successive seasons, wood frogs, leopard frogs, toads and salamanders (species unknown, probably *Amblystoma punctatum*) have been observed to lay their eggs in a small pool in the college park. Each spring it has been noted that the eggs of the salamanders only had a greenish color. Microscopic examination shows that this is due to great numbers of a very small unicellular green alga found within the inner mass of jelly. The green color grows more marked as the development of the eggs takes place, due presumably to the larger amount of CO_2 given off as the larvæ become more active. Since no algæ have ever been found in the outer or general mass of jelly, it seems possible that they may penetrate the oviducts of the salamander and become enclosed in the inner capsule of jelly as the eggs pass to the exterior.

B. *Some Plant Abnormalities.*—A bifurcated frond of the common Boston fern was exhibited. This was one of two growing on one plant in the writer's laboratory at the present time. Three years ago two others were noticed on different plants.

A drawing was exhibited of a motile *Hæmatococcus* with four flagella. This was found last fall in a lot of fresh material from a cemetery urn.

Conjugating Yeasts: W. C. COKER, University of North Carolina, Chapel Hill.

In the course of experiments by an advanced class in the fall of 1910 the rare and peculiar wild yeast, *Schizosaccharomyces octospora* Beyerinck, was found. It appeared in test-tubes that were filled with distilled water in which were a number of unbroken Delaware grapes that were bought in the local market. A day or two after the tubes were prepared a slow fermentation set up, and later a precipitate appeared. On examination of this precipitate after three weeks it was found to contain the *Schizosaccharomyces* in process of conjugation. A later experiment made with Tokay grapes gave a similar result. Cultures were continued and the life history studied in all stages, confirming in general the observations of Guilliermond. Four species of *Schizosaccharomyces* are known, all supposed to be tropical or subtropical, and *S. octospora* has not been found before in America.

Results of a Practical Attempt to Control Lettuce Sclerotiniose: F. L. STEVENS, North Carolina College of Agriculture and Mechanic Arts, West Raleigh.

Lettuce sclerotiniose has been the subject of investigation for several years in the North Carolina Agricultural Experiment Station. From the laboratory study it was concluded that all structures except the sclerotium are short lived; therefore, that if the formation of new sclerotia could be prevented diseased beds could eventually be restored to health. To test this theory several experimental beds were very thoroughly infected in April, 1908, by heavily inoculating a large number of plants and allowing the sclerotia which were formed to remain in the beds. The following year 555 plants, or over 45 per cent., died of sclerotiniose. From this time on a course of treatment designed to prevent the forming of sclerotia was followed with the hope of lessening the disease. The following year only seven plants, or one half of one per cent., of the crop died. A year later, that is, the present year, the results were almost the same. This experiment seems to indicate that control of this disease can be obtained by the methods employed.

Studies in Soil Bacteriology, V.—The Nitrifying Powers of North Carolina Soil: F. L. STEVENS and W. A. WITHERS, assisted by P. L. GAINEY, F. W. SHERWOOD and T. B. STANSEL.

During 1909 and 1910 samples were taken from 58 localities representing 21 different soil types, in each of which was a good soil and a poor soil. The soils came from sixteen counties. Nitrification was expressed as N. E., N. I. P. and N. I. P. in Solu., which terms have been explained in previous publications.[1]

A summary of the results is:

	N. E.	N. I. P.	N. I. P. in Solu
Maximum found	105.1	89.9	1.5
Average for good soil .	8.7	44.7	0.6
Average for poor soil .	5.0	34.8	0.6
Average for all soils .	6.8	39.8	0.6

There is seen to be a great difference in results by different methods of testing. There is also a difference between the results obtained by the same method on samples taken from the same

[1] *Centralblatt f. Bakt.*, Abt. II., Bd. 25, 1910, p. 64.

field if the two samples are taken a year apart. N. I. P. in soil gave the higher results on an average, but not always in individual cases, showing that our soil 1931, which has been used so much, affords better conditions for nitrification than most of our soils.

N. I. P. in solution shows no correlation with fertility. N. I. P. in soil shows better nitrification with the good soil in 69.2 per cent. of the pairs. N. E. shows no nitrification in either the good or poor samples in 29.6 per cent. of the pairs, but where there is nitrification it shows better in the good in 63.2 per cent. of the pairs. There are several samples in which the poor soil shows better N. E. and N. I. P. than the good soil.

Some Points on Architectural Acoustics: Andrew H. Patterson, University of North Carolina, Chapel Hill.

An account of experiments made by the author and Mr. A. L. Field on the acoustics of Memorial Hall at the University of North Carolina. The reverberation in this hall is very bad, and the problem is complicated by bad echoes due to large flat panels in the dome-shaped ceiling. Further experiments will be undertaken in an attempt to find a complete solution of the difficulty.

Preliminary Report on the Regeneration of Nemerteans and Amphitrite: Judson D. Ives, Wake Forest College, Wake Forest, N. C.

Sections of nemerteans were found to regenerate readily and rapidly. But little new material formed on the anterior surfaces. Small sections, not more than 1.2 cm. long, in twenty-five days regenerated 2.5 cm. on their posterior surfaces. A section, 2.1 cm. long, regenerated 1.5 cm. in twenty-five days. A worm, with its posterior portion cut off, its head and the remaining anterior portion measuring 10.2 cm., regenerated 1 cm. in twenty-nine days.

In Amphitrite, the tentacles regenerate readily. Worms, with the portion in front of the second pair of branchiæ removed, thereby removing the tentacles and the first pair of branchiæ, lived for thirteen days, and were in good condition when killed.

A Dangerous Apple Disease: F. L. Stevens and Guy West Wilson, North Carolina College of Agriculture and Mechanic Arts, West Raleigh.

This disease came to our notice in 1909 from Lincoln County, where it appeared in 1908 on a single tree and despite the cutting out of all disease seen and spraying with lime-sulphur it spread the next year to thirteen trees. The same trouble appeared in Sampson County in 1909 with even more disastrous results.

Whitish or pinkish pustules appear on the younger twigs and about the crotches of the tree. These bear numerous spores of the *Fusarium* or *Tubercularia* type, but so far no ascigerous form has been connected with them. The infection is in the bark, the diseased areas shriveling and separating. The epidermis splits away, exposing the browned surface beneath, or the pustules merely break through the epidermis, especially near the lenticels. Upon older twigs the bark cracks longitudinally, exposing rows of pustules in the cracks. A pinkish mycelial growth sometimes appears on the diseased twigs.

Condimental Feeds, Stock and Poultry Tonics and Conditioners: G. M. MacNider, Department of Agriculture, Raleigh.

A review of the work done by the author on proprietary stock and poultry medicines, the results of which have been published in full in a recent bulletin of the North Carolina Department of Agriculture.

Sixty-four preparations were analyzed chemically and microscopically. They were found to be composed largely of a base material such as cotton-seed meal, oil meal, wheat bran, etc., with small amounts of drugs added. Thirty-four drugs were identified in the preparations examined. The ones used in largest amount are practically worthless as medicines, while those that are of value are used in such small amount that they can have no effect.

The Turkey Buzzard Must Go: George W. Lay, St. Mary's School, Raleigh.

Originally "the birds of the air and the beasts of the field" were the recognized scavengers. The dog even now is so used in oriental countries, but in a higher civilization his services have been superseded by more modern methods.

The turkey buzzard spreads diseases such as chicken pox and hog cholera chiefly by infection carried on the feet. Owing to his great range of flight he carries disease from the point of infection to places far distant. If burial, the proper method for disposal of dead bodies, is used, he becomes a predatory bird, killing chickens, young pigs, etc. He is therefore a dangerous bird and should no longer be protected by law.

To be published in full in the current number of the *Journal of the Elisha Mitchell Scientific Society.*

The Library of Congress as an Aid to Scientific Research: E. W. GUDGER.

The Library of Congress, with its vast aggregations of books and journals, including the priceless Smithsonian collection, is the greatest aid in America to the historical side of scientific research. Through the system of inter-library loans, nearly any and all of this enormous mass of literature is available to the scientific researcher, provided that his college library bear the cost of transportation. The writer has during the past five years carried on three separate extensive historical researches in ichthyological literature which would have been impossible without access (at a distance) to this great library. It is a pleasure to record the prompt and efficient service with which every one of many requests for books has been met, and to call the attention of scientific men to this great adjunct to their work.

Occurrence of the Yellow Fever Mosquito at Raleigh: C. S. BRIMLEY, Raleigh.

In the summer of 1910 the writer found a rather small mosquito with white banded legs to be common in his house in the daytime. On investigation this proved to be *Stegomyia calopus,* the species which transmits yellow fever. The species was active all day, biting even at noon in a well-lighted room, while mosquitoes taken after dark almost invariably turned out to be other species. The species has not been taken by other Raleigh entomologists. No breeding places were discovered.

Proposed Reform in our Calendar: ANDREW H. PATTERSON, University of North Carolina, Chapel Hill.

A discussion of the various methods proposed in recent years for the reform in our present calendar.

Some Interesting Water Molds: W. C. COKER, University of North Carolina, Chapel Hill.

The occurrence in Chapel Hill of *Thraustotheca clavata* (DeBary) Humphrey was reported. It seems to have been found previously only at Strassburg, Germany. In this singular mold the sporangial wall dissolves away almost completely, suggesting the method of spore liberation in *Rhizopus,* and the encysted spores are allowed to fall apart in all directions. The spores escape from their cysts in the laterally ciliated form, showing that the first swimming stage is suppressed.

There also occurs in Chapel Hill a species of *Dictyuchus* in which the entire sporangium breaks away from the hypha as soon as the spores become distinct. After some time the spores escape singly through individual tubes as is normal in the genus. Other points reported were the appearance of a variety of *Achlya americana* with hypogynous tubes, the occurrence in Chapel Hill of *Achlya racemosa* Hildeb., and the fact that *Saprolegnia diclina* Humphrey is at least not always diœcious.

Rhizoctonia of Buckwheat: F. L. STEVENS and G. W. WILSON, North Carolina College of Agriculture and Mechanic Arts, West Raleigh.

Mention was made of a serious outbreak of rhizoctoniose on buckwheat in the western part of North Carolina.

The Finned-tailed Larva of the Butterfly Ray, Pteroplatea maclura: E. W. GUDGER.

The adult ray has a very short tail, in length about equal to one third of the body, with very faint traces of dorsal and ventral finfolds. A photograph was exhibited of three young attached to flattened yolks, showing each embryo with a profusion of long external gills and a tail three fourths as long as the body. All three larvæ have the hinder halves of their tails distinctly finned above and below, thus forming broad paddle-like organs. The significance of this in the phylogenetic history of this ray is very great.

More than half the material is at hand for the embryology of the fish, and an effort will be made to collect the remaining stages this season.

The Whistling Arc in the Study of Auditorium Acoustics: C. W. EDWARDS, Trinity College, Durham.

Employing the well-known device of using a sound emitting light for a source of sound waves, a whistling arc was used for investigating confusion and distortion in an auditorium. The very large variety of sharp clear notes that the arc could be made to emit by varying the inductance made it especially useful in the study of the less practical problem of distorsion. Small mirrors were used, following the method of F. R. Watson, of the University of Illinois, to trace the path of the sound waves after reflection from various surfaces.

No abstracts have been received for the following papers:

Survivals along the Sea Islands from Hatteras to Key West: COLLIER COBB, University of North Carolina, Chapel Hill.

The Peat Deposits of North Carolina: JOSEPH H. PRATT, Chapel Hill.

Isoetes in North Carolina: W. C. Norton, North Carolina College of Agriculture and Mechanic Arts, West Raleigh.

The Composition of Melted Kauri Copal, as Used in Varnish Making: Charles H. Herty and C. S. Venable, University of North Carolina, Chapel Hill.

Results of some Preliminary Studies in Wing Vein Homologies, Homoptera cicadina (lantern): Z. P. Metcalf, Department of Agriculture, Raleigh.

Regressive Differentiation in Hydroids and Sponges: H. V. Wilson, University of North Carolina, Chapel Hill.

A Striking Class-room Experiment after Otto von Guericke (by invitation): J. M. Pickel, Department of Agriculture, Raleigh.

Recent Changes of Level from Cape Hatteras to Cape Sable (lantern): Collier Cobb, University of North Carolina, Chapel Hill.

How to Discover the Solution of a Problem: John F. Lanneau, Wake Forest College, Wake Forest.

Mineralogical Notes on Rutile, Pyrophyllite, Talc and Graphite: J. H. Pratt, Chapel Hill.

Some Interesting Variations in the Flowers of a Local Vinca: W. C. Norton, North Carolina College of Agriculture and Mechanic Arts, West Raleigh.

Road-surfacing Materials: Joseph H. Pratt, Chapel Hill.

Some Seedlings of the Scuppernong Grape (by invitation): F. C. Reimer, Department of Agriculture, Raleigh.

The Postulates of Relativity: C. W. Edwards, Trinity College, Durham.

E. W. Gudger,
Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

At the meeting of the American Philosophical Society, Philadelphia, on May 5, 1911, an address on lignite was delivered by Dr. Joseph A. Holmes, director, Bureau of Mines, Washington, D. C.

The extent of the lignite deposits in the United States will be realized from the following figures giving the areas in several of the states:

Alabama	6,000
Tennessee	1,000
Louisiana	8,800
Arkansas	5,900
Texas	53,000
South Dakota	4,000
North Dakota	31,000
Montana	7,000

In a number of states in the Rocky Mountain region there are large areas of coal that represents a transition between typical lignites and bituminous coals. For these the name "subbituminous coals" has been suggested, and is tentatively used by the United States Geological Survey.

The lignite beds in Alabama, Mississippi and Tennessee represent a transition between peat and the more typical lignites of the Dakotas and Texas. Little or no use has been made of the lignite beds in these three states.

The lignites in Texas and Arkansas have been used to a limited extent; as have also the lignites of the Dakotas and eastern Montana. In this latter field the lignites contain 20, and in some cases more than 40, per cent. moisture, and slack badly and rapidly on exposure to the atmosphere; and this quality seriously interferes with their use and value for fuel purposes.

The outlook for the utilization of lignites is favorable along three lines: (1) In gas producers, without either drying or other treatment; (2) in boilers of special construction, such, for example, as that installed more than a year ago at Williston, N. D., by the United States Reclamation Service, where the lignite is used in its natural condition almost immediately after being brought from the mine; (3) in the form of briquettes. This requires that the lignite should be thoroughly and finely crushed and dried to a moisture content of from five to ten per cent., and then compressed while still warm into briquettes.

Limited quantities of lignite from California, North Dakota and Texas have been made into satisfactory briquettes at the Government Mine Experiment Station at Pittsburgh, using the full-sized German briquetting press, which develops a pressure of twenty to twenty-five thousand pounds per square inch. In the cases just mentioned the briquettes were made without the use of any binding material, a sufficient amount of tarry material remaining in the crushed and dried lignite to serve as a bond to hold the particles together in the briquette.

It is believed that our investigations along this line will demonstrate the fact that the lignite in Texas, and the Dakotas and Montana can be made into briquettes on a commercial scale, and that in this form the lignite can be used as a substitute for other domestic fuel in these regions.